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several points in the structure of the humming-bird's tongue. This organ is tubular, but as it lacks any pumping apparatus it can take fluids only by capillary attraction. Lucas thinks it is rather an instrument for the capture of small insects, a view supported by the size of the salivary glands.—*Tetraprion jordani* is the name of a new tree toad from Ecuador described⁹ by Dr. L. Stejneger and Mr. F. C. Test. It differs from all other Hylidæ in the presence of palatine teeth.—A recent paper by Barton A. Bean¹⁰ on the fishes of the Chesapeake is interesting from its richness in local names. Thus, the file-fish is locally called fool-fish; the flounder (*Paralichthys dentatus*) is the chicken halibut; the toad-fish, bull-fish; *Stromateus paru*, butter-fish; the weakfish as trout or gray trout; scup is maiden; the sea-bass is black will or black nell; the blue-fish is tailor; the menhaden is old wife, etc.

EMBRYOLOGY.¹

Embryology of the Sea Bass.—Dr. H. V. Wilson has published in the bulletin of the United States Fish Commission for 1889, Vol. IX., a contribution to the embryology of *Serranus atrarius* in particular, and teleostean embryology in general. The paper covers sixty-eight pages of text, and is accompanied by twenty photo-lithographic plates. Dr. Wilson has given a most excellent account of the development of a single fish, from the egg to the time when the young fish hatches. To those desiring a simple and straightforward account of fish development, brought up to date, the present contribution will meet every want. As a contribution of original research the different parts are of different values. For instance, while the sections on gastrulation, concrescence, and the formation of the lateral line are valuable, and largely, more especially the last, original contributions to modern embryology, yet the sections dealing with the central nervous system, blood vessels, notochord, gill-slits, anterior body-cavities, etc., are by no means so fully treated, and little addition is made to our present knowledge. This, perhaps, is a necessity of the attempt to cover so large and so well worked a field; indeed, one of the most prominent facts brought out in the paper is that the grounds seem so

⁹ Proc. U. S. Nat. Mus., XIV., p. 167, 1891.

¹⁰ Proc. U. S. Nat. Mus., XIV., p. 83, 1891.

¹ Edited by Dr. T. H. Morgan, Johns Hopkins University, Baltimore.

thoroughly to have been covered by previous writers, and the author attempts to show in the fairest manner possible which of the (always) several accounts is the more probable from his "observations on the bass." We may now pass critically over the different sections of the paper.

The egg of the sea bass is a small pelagic egg, about one mm. in diameter. Imbedded in the yolk, but near the surface, is a single large oil globule, which is always uppermost in the floating egg. After fertilization the protoplasm, which heretofore formed a thin layer over the egg, begins to flow to the pole opposite to the oil globule (lower). This patch of protoplasm at the lower pole is at first circular. Just before or during the first act of cleavage there arises an inequality in the axes, so that by the time the first two blastomeres are marked off the germ is bilateral. In the bass and mackerel the first two blastomeres are of equal size. "This is normally so with the cod as well; but on one occasion I observed that in all the eggs got from a single codfish the first two blastomeres were unequal in size. The inequality was very marked; but the eggs were healthy and the average percentage of fish was hatched out."

This observation, which the author does not further follow up, must have an important bearing on the relationship of the first cleavage furrow to the plane of the adult body, and hence on the problem of the quantitative relationships of protoplasm (and nucleus?) in cell division. The somewhat hasty generalization, that in the Triploblastica the first cleavage plane divided the egg into right and left halves with reference to the adult, is meeting with general and inexplicable exceptions; and it is the exceptions determined by casual observation as the above that show clearly that we do not yet understand the relationship between egg cleavage and adult structures.

"The teleostean segmentation [cleavage of the egg] has undoubtedly been derived from a total segmentation essentially like that of Amphibia; and convinced of this, Rauber, Agassiz and Whitman, and Ziegler have endeavored to homologize the early furrows in the two groups. In regard to the first two furrows there can be no difference of opinion. The homology of the third teleostean furrow is by no means so clear. Ziegler, without entering into a detailed discussion of the matter, regards the first three furrows in the two groups as homologous. Agassiz and Whitman, after a critical examination of Rauber's views, also pronounce in favor of this homology, deciding that the third teleostean furrow represents the equatorial furrow of Amphibia. I do not find, however, their reasons sufficient for discarding the homology offered by Rauber, supported as it is by variations (atavistic) in the teleostean germ toward

the amphibian segmentation which so exactly imitate the teleostean types. . . . According to Rauber, the first equatorial furrow of the frog has been lost in the Teleost. Agassiz and Whitman would seem to believe that the *a priori* improbability of such a loss taking place is so great that, in spite of the variations just described, it is preferable to regard the first three furrows as homologous in the two groups. I do not see the inherent improbability of the loss. On the contrary, the disappearance of segmentation in the ventral half of the egg, coupled with the early contraction of the protoplasm (belonging to this half) towards the upper pole, make it easy, I think, to understand how the loss was brought about." The author seems to have come to this conclusion largely on account of the close resemblance in the arrangement of the eight micromeres in the 16-celled frog's egg with the eight-celled stage in the bass; but inasmuch as there exist the greatest individual differences in the arrangement of the micromeres in the frog, and also in the fish, we have every reason to believe such a general resemblance might have been independently acquired in each case, and that the eight-celled stage in the fish corresponds to the 16-celled stage in the frog; and that the resemblance between the 16-celled stage (eight micromeres, eight macromeres) in the frog and the eight-celled in the fish is entirely superficial. Moreover, if, as the author attempts to show, the fish gastrula may be derived directly from the frog's gastrula, we have every reason to believe that so fundamental a process as the cleavage stages must be similar, making a very strong "*a priori* improbability" that the third furrow of the frog has dropped out of the fish egg.

As is well known, the eight-celled stage of the frog separates in general the micromere cells of the upper (anterior?) pole from the lower cells containing more yolk. Now if the view taken by Agassiz and Whitman be true, it would seem probable that in the eight-celled stage of the fish four (most probably the more central four) cells would be entirely cut off from the protoplasm covering the yolk, and that the other four cells would have their protoplasm continuous, in part at least, with the protoplasm covering the yolk. To some extent the author's figures bear out such an interpretation, although he does not seem to have examined the sections from such a point of view.

The origin of the periblast in the bass is the same as is described in *Ctenolabrus* by Agassiz and Whitman. "These authors proved beyond a doubt that in *Ctenolabrus* the nuclei are derived from the marginal cells of the blastodisc, which from the earliest stages of segmentation are connected with the yolk or periblastic protoplasm." (See above.)

The whole of the periphery of the blastoderm turns in, forming a layer between the periblast and the superficial ectoderm of the animal pole. The invaginated layer from the posterior pole gives rise to the mesoblast and notochord by delamination, and the remaining cells go to form the midgut, the periblast taking no part whatever in the latter structure, but remaining encircling the yolk, and ultimately assisting to digest it when it begins to disappear by absorption by the liver cells. The blastodermic cap grows over the yolk. "As the blastopore grows smaller, the extra embryonic part of the germ-ring is *pari passu* drawn into the tail end of the embryo, and there is thus built up in this region a constantly increasing wall of undifferentiated cells. . . . In the bass there is no actual concrescence in the middle line; but the terminal notch observed in some fish, as well as the general considerations derived from a comparison of Teleost with Amphibia, warrant us in regarding the closure of the blastopore as a process of concrescence, the result of which is to establish the primitive streak. The entire mass of undifferentiated cells left at the tail of the embryo after the blastopore closes serves as a cellular material for the backward growth of the several organs. Thus, while the extra embryonic germ-ring, as has been insisted upon by Agassiz and Whitman, and Cunningham, assuredly forms part of the embryo, it does not form any special part; but, on the contrary, its cells eventually find their way into ectodermic, mesodermic, and notochordal tissues" of the tail. In other words, the author believes the two halves of the trunk of the embryo are not formed by concrescence of the blastopore, mesoderm, or any modification of it, but that all of the mesoderm turned in around the rim (except at the post-embryonic pole) accumulates at the upper ridge of the blastopore (in the caudal mass) and at its sides, and this latter differentiates into the mesoderm and its products in the tail.

"The alimentary canal is formed from the simple endoderm lamella [invaginated endoderm without the parablast] by a process of folding along the median line. The fold is converted into a tube by the meeting of its lower edges. There is a solid postanal gut formed as a thickening of the endoderm lamella, not as a fold. At the end of the postanal gut is Kupffer's vesicle, which is formed in essentially the same way as the permanent alimentary tube. It is scarcely necessary to say that Kupffer's vesicle and the entire post-anal gut [subsequently] atrophy." "The discovery of this vesicle was made by Kupffer in

1868, and since then it has occupied a conspicuous place in the embryology of Teleosts. . . . The alimentary canal is formed by a process of folding, and Kupffer's vesicle, as the terminal part of the postanal gut, follows the same method. After the gut has once been folded off, the homology of the vesicle with the postanal vesicle of Selachians is obvious. In each group the vesicle forms the dilated extremity of the postanal gut, and receives, or would receive if it existed, the neurenteric canal. . . . But if Kupffer's vesicle in its early stages indicates that the terminal portion of the archenteron was primitively dilated, we naturally inquire both for the causes and for a corresponding phenomenon in the ontogeny of those animals in which the archenteron is bodily transformed into the permanent gut. As to the latter point it would seem very common in the Amphibia for the archenteron to be thus dilated. The existence of such a dilatation in the enteron of the primitive Chordata is further made probable by, and receives an explanation from, the relation of the neurenteric canal to the blastopore. It will be seen that in the interpretation of Kupffer's vesicle I substantially agree with Cunningham: it is the terminal part of the archenteron."

The most interesting addition to our knowledge is the author's discovery that the ear, branchial sense-organs, and organs of the lateral line arise from a common structure or embryonic "anlage." "It has been noticed in the trout that the anlage which was supposed to develop into the ear is remarkably long. I have found that this anlage not only gives rise to the ear, but to a functional branchial sense-organ and to the organs of the lateral line as well. Before the blastopore closes there is found behind the eye a long, shallow furrow [the sensory furrow] in the nervous layer of the ectoderm. At two points the furrow begins to deepen, the deepening taking place downwards and inwards. At these two points the auditory sac and the branchial sense-organs will respectively be formed. . . . A further stage in the development shows that the deepening of the furrow in the auditory and branchial sense-organ regions has continued until there are two well-marked sacs, the anterior of which is the branchial sense-organ, the posterior the auditory sac. Between the two sacs persists the connecting portion of the sensory furrow, and behind the auditory sacs the furrow is continued for some distance. *The posterior portion of the furrow constitutes the anlage of the lateral line.*

"The homology instituted by Eisig between the lateral line organs of fishes and the 'seiten organ' of certain Annelids is well known. Balfour, in his text-book, declined to accept it; and though Beard

favoured the homology in his paper on the teleostean lateral line, after studying the Selachians he gave it up. Now that the early development of the lateral line is approximately known in Teleosts and Selachians, there seems less than ever to be said for the homology. If it could be shown that the segmental sense-organs of Annelids, leeches, etc., arise from an anterior anlage, which grows and, so to speak, distributes the sense-organs along the trunk, the homology might well be supported. But as far as I know the invertebrate segmental organs arise *in situ*."

"The fact that there is in the bass a common anlage for the ear, branchial sense-organ, and lateral line has certainly no phylogenetic significance. It can only be regarded as a convenient method of forming these sense-organs which the embryos of certain animals have adopted. It, however, serves to emphasize in a striking way the serial homology between the organs which previous work has already made so probable." The interpretation of this latter quotation is somewhat obscure and the author's meaning difficult to read between the lines. If he means that the ear, branchial sense-organs, and lateral line have arisen in the adult in the same position found in the adult to-day, and have subsequently concentrated in the embryo into a single anlage, he brings no evidence forward to support his position. If he means that in the adult these three sets of organs arose from a single anterior organ, and the ontogenetic phases repeat the ancestral process, then the theory seems in better accord with the facts, but his words seem to bear out no such interpretation. At any rate, to announce that in their origin, which he has himself discovered, there is no "phylogenetic significance" seems an extremely hazardous affirmation. In any case, however, the discovery itself is extremely important, and may have an important bearing upon the question of metamerization of the vertebrate as contrasted with that of the Annelid.

The last section deals with "General Morphological Questions," touching mainly upon concrescence and the interpretation of the process of gastrulation in the Teleost. "In the growth of the blastoderm around the yolk, the head end of the embryo does not remain a fixed point, as His supposed. On the contrary, the tail end of the embryo (posterior pole of the blastoderm) remains a comparatively fixed point, as Oellacher first showed, while the anterior pole of the blastoderm travels rapidly around the yolk. The point where the blastopore closes is thus but a short distance from the original position occupied by the posterior pole of the blastoderm. Owing to the constant position of the single oil globule, these facts can easily be

made out." This argument itself is vitiated in the assumption of a fixed point for the oil globule, as the author gives little reason for believing that the latter may not change position with the growth of the embryo. Moreover, and this is much more important, the author's conception as to the position of the frog's gastrula in relation to the poles of the embryo may not be correct, and must seriously alter his conception of the position of the fish embryo to the egg if he insists on a strict comparison of the two forms. (See below.)

The author's conception of gastrulation in the fish may be gathered from the following quotation: "Accepting Ziegler's homologies, it will be seen that the whole course of the fish development becomes easy to understand. Starting with the blastula, and disregarding for the present the non-embryonic part of the germ-ring, the primitive hypoblast corresponds to the primitive hypoblast which invaginates around the dorsal lip of the blastopore in the frog gastrula. The chief point of difference is the lack of continuity in the fish embryo between the inner edge of the invaginated layer, and the yolk is easily explained as an adaptation to the method of forming the alimentary canal from the invaginated layer exclusively. The archenteron lies between the primitive hypoblast and the periblast. In consequence of the absence of continuity between the yolk and the invaginated layer, the archenteron at its edge is not separated from the segmentation cavity. *The growth of the anterior pole of the blastoderm around the yolk represents the growth of small cells around the yolk-cells in amphibian gastrulation.* The closure of the blastopore takes place in the same way as in the Amphibia; there is formed a short primitive streak behind the position of the neurenteric canal (Kupffer's vesicle in Teleosts); at the posterior end of the primitive streak the final closure takes place. . . . The asymmetry which Balfour showed to be a characteristic attribute of vertebrate gastrulation is present in the highest degree in the Teleost gastrula. At the posterior pole of the blastoderm (dorsal lip of blastopore) there is an extensive invagination which gives rise to the roof of the archenteron. The cause of the asymmetry must be looked for in the peculiarly localized distribution of the yolk in the egg."

The italics above are my own, and emphasize the fact that the author does not realize that in the gastrulation of the Amphibia, to which he so constantly refers, the anterior pole does not grow over the yolk in an epibolic fashion, but that the anterior (black) extension of the blastoderm over the yolk takes place by a delamination of ectoderm cells from the large yolk-containing cells (see AM. NAT., Embryology, August, 1891). This latter view has been recognized by Kupffer and

Hertwig. "Now the growth of the blastoderm over the yolk does not take place, according to Kupffer, in a true epibolic fashion, but is accomplished through the medium of a zone of tissue in which the yolk-cells become transformed into the cells of the two primary layers. Hertwig holds the same opinion. If this be really the case in Amniota, two explanations of the process are possible: First, that it is a modification of the ancestral, epibolic growth, such as occurs in Teleosts, which view Kupffer and Hertwig would of course reject, because it is equivalent to admitting the homology of the blastoderm edge in Teleosts and Amniotes, and consequently the correctness of the Balfour-Rauber hypothesis; secondly, that the process is, to refer it to simple embryonic forms, one of progressive delamination. It will be seen that Kupffer's hypothesis really implies the occurrence of the latter process, for when he explains the spreading of the blastoderm as the completion of the blastula stage he really means that the embryo splits off ectoderm progressively from a to a^1 towards m (anterior embryonic portion). Thus, again, to refer the processes to their simplest forms, over one half of the blastula (yolk half) delamination occurs; but in the other half there is a true invagination (region of prostomia and primitive streak). . . . However, the analysis I have given is, I think, a perfectly fair one, and the result is evidently prejudicial to their theory. For the conclusion is that the Amniotic vertebrates have a blastula which invaginates over one half and delaminates over the other. Such an embryonic form is nowhere known to occur, and the theory which is forced to assume its existence is in so far a weak theory, and must give place to any other which can explain the facts by making use only of known processes." Unfortunately for the author, the weak theory is probably to be regarded as a real fact, and if so the author's argument collapses. Whether or not a readjustment of the author's views may show him to be largely in the right, is another question for the future to settle. Meanwhile any conception of fish (and Amniote) gastrulation must take into account as a starting point the delamination over the anterior and ventral face of the early stages of the frog's development.—T. H. M., *September 9th, 1891.*

The Development of Hydra.²—The ground already covered by Kleinenberg ('72), Kerschler ('89), and Korotneff ('83) has again been worked over by Dr. August Brauer. The following species of brown ("not green") hydras were studied: *H. grisea*. Eggs and

² *Zeit. Wissen. Zool.*, Bd. 51, Heft. 2, 1891.

spermatozoa. May, June, and July. Bisexual. The eggs fall off from the mother as soon as the outer coat of the embryo is formed. The embryos do not hatch for one or two months. *H. fusca*. Eggs mature in October. Bisexual. The eggs do not fall off, but are stuck to surrounding objects by means of a jelly, and flatten down somewhat on the support. Probably the eggs are deposited in different places. The time between egg-laying and hatching is as in the last species. *H. sp. ?* Adult resembles closely *H. fusca*. More than half of the individuals kept in the aquarium developed into males alone, and later after the disappearance of the testes they did not develop eggs, but continued to bud. The remaining individuals developed into females. The eggs remain attached to the mother. When all of the eggs have developed as far as the two-layered stage the mother contracts strongly her body down to the base. The eggs come to lie around the base of the mother, remaining sticking to her. The mother remains in this strongly contracted condition for several weeks, and the embryos often escape from the shell before the parent again extrudes. Three embryos hatched in one case fourteen days after the contraction had taken place.

The author suggests that the adult species may be identified in the form of the eggs and the structure of the egg-case :

1. *Hydra viridis*. Egg falls off. Form spherical. Case smooth.
2. *Hydra grisea*. Eggs fall off. Forms spherical. Case covered with large and often branched spines.
3. *Hydra fusca*. Eggs singly stuck to objects. Form below, flat ; above, convex. Case covered with spines only on the upper surface.
4. *Hydra sp. ?* Eggs (at base of mother) generally all stuck at one place. Form spherical. Case covered with short spines.

The maturation and fertilization of the egg is described in much greater detail than ever before. The egg begins to round up, drawing in the protoplasmic processes, but still remaining beneath the ectoderm. At this stage the *two* polar bodies are extruded. The egg later breaks through the overlying ectoderm, but remains attached by a broad base. Fertilization then takes place.

The eccentric position of the segmentation nucleus causes the first furrow to begin at the distal pole (away from the mother), and then, after many changes in the outline of the egg, the yolk follows the nuclear division, and moreover, *in the same way as Bergh³ describes in Gonothyræa,—viz., the nucleus divides a second time, and the second*

³ *Morph. Jahrbuch*, Vol. V., 1879.

*furrow is visible while the first furrow has not finished.*⁴ With the passing of the furrows through the egg the nuclei pass to the middle. If they have reached this after the end of the second cleavage, then the segmentation proceeds more rapidly and regularly.

A blastula stage follows, and from it the endoderm is formed at all points over the surface, by both delamination (Theilung) and migration (Einwanderung). Later the blastula cavity is filled with solid endoderm. From the ectoderm the outer chitinous case is secreted, and later the inner germ-membrane. The ectoderm remains intact, and goes over into that of the adult. The sequence of the appearance of the tentacles does not follow any defined law. The mouth-pole is in all probability identical with the pole that gave rise to the polar bodies.

Morphology of the Vertebrate Head.⁵—In the *Anatomischer Anzeiger* (VI. Jahr., '91) Julia B. Platt publishes a contribution of the "work presented last October for publication in the *Journal of Morphology*." The present paper deals with the origin of the head segments and their nerve supply. "The anterior limit of the fusion of the edges of the neural plate is therefore not the neuropore, but the anlage of the optic stalk. . . . The optic nerve which later develops into the optic stalk is therefore primarily a dorsal structure, and morphologically the first or most anterior of the cranial nerves. Anterior to the first gill-cleft, *Acanthias* has therefore seven pairs of somites,—three for the hyoid arch, two for the mandibular, one pre-mandibular, and one 'anterior.' "

In the Teleost *Batrachus* the author says: "My study of the development of the mouth in *Batrachus* but confirms the work published many years ago by Dohrn on the development and significance of the teleostean mouth. At an early stage a pair of pockets from the alimentary canal open to the exterior anterior to the hyomandibular clefts. Much later in the development of the embryo the mouth *breaks through in the ventral region* of these pockets as a bilateral involution of the ectoderm, fusing with the endoderm, and opening to each side of a central partition sometimes before the median line is

⁴ The italics above are my own. The relation between the cleavage of the protoplasm and the division of the nucleus is a parallel case to that observed by Mayer in *Pagurus* and by E. B. Wilson in *Renilla*, and are most suggestive facts as to the relation existing between nucleus and cell-body, and while not proving that protoplasmic phenomena may take place independently of the nucleus, yet show that the nucleus does not dominate all cytogenic phenomena.—T. H. M.

⁵ *Anatomischer Anzeiger*, VI. Jahr., Nos. 9 and 10, 1891.

crossed. The little fish is at this stage so large that the double nature of the mouth involution may be seen without aid of a lens. The author is not committed as to whether the breaking through of the ventral region represents a pair of gill-clefts,—*i.e.*, as to whether the Teleost (and vertebrate) mouth arises, as Dohrn supposed, from a ventral fusion of a pair of fused gill-clefts.

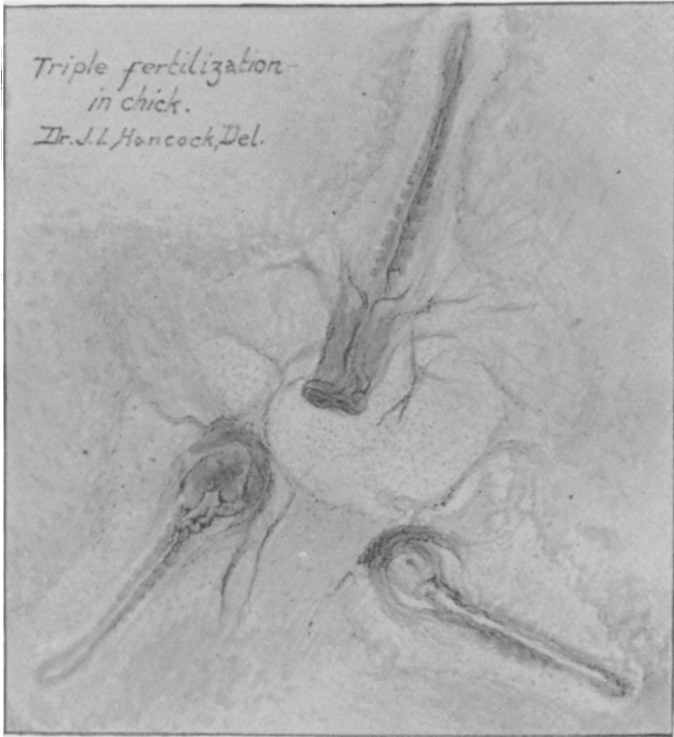
Triple Fertilization in Egg of Domestic Fowl.—The infrequency with which triple fertilization takes place in the same ovum, in birds or mammals, is in itself reason for presenting to the scientific student what appears to be a unique specimen illustrating this phenomenon, and upon which may also rest the basis of certain biological speculations. In view of this I have drawn the specimen (see Plate XXII.), shown for the first time, representing topographical features rather than histological detail.

The literature at my disposal and such inquiries as it was possible for the writer to make from reliable sources failed to recall another recorded instance of triple fertilization occurring in domestic fowl. It is in this connection interesting to note that Hertwig, Fol, Pluger, and other observers of note are unanimous in the conclusion that "polyspermy," or more than one spermatazoa entering the ovum, is extremely rare, and, as a matter of fact, generally impossible; and where it does occur in rare conditions, it indicates a pathological condition of the egg-cell, giving rise to the production of abnormalities.

Here we have, in all probability, the entrance of three sperms into the ovum,—a condition indeed so rare as to excite more than ordinary interest in the mind of the naturalist.

I am indebted to Dr. J. C. Millman, formerly in the biological laboratory of the University of Wisconsin, for the generous spirit with which he brought to my notice and allowed me the pleasure of laying the specimen before the reader.—DR. JOSEPH L. HANCOCK, *Chicago, September 29th, 1891.*

PLATE XXII.



TRIPLE FERTILIZATION IN EGG OF DOMESTIC FOWL.
(About thirty-eight hours old.)